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METHODS OF CLASSIFICATION OF ELECTROENCEPHALOGRAM DATA FOR IDENTIFICATION OF HUMAN EMOTIONAL STATE

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Abstract. *The developed methods for classifying electroencephalogram (EEG) signals enable the identification of brain responses to emotional stimuli, which serves as the foundation for constructing neurointerface systems. The result of the classification process is the assignment of a control EEG to a corresponding cluster that matches a specific emotional state.*

Key words: *electroencephalogram, emotion recognition, cluster analysis, statistical analysis, barycenter signature*

Introduction.

The study of the brain's electrical activity is one of the key areas in modern neuroscience. The electroencephalogram (EEG) contains encoded information about neurophysiological processes that reflect the organism’s internal response to external stimuli. Due to the complex, multi-layered organization of brain activity and the interdependence of physiological processes, extracting this information in a clearly structured form remains an extremely difficult task [1].

Traditional EEG structural analysis methods have proven to be insufficient for accurately isolating individual brain responses and establishing reliable links between brain electromagnetic activity and external environmental influences. Meanwhile, recent studies demonstrate the effectiveness of intelligent approaches to analyzing large EEG datasets, enabling the identification of statistically reliable correlations between characteristic parameters of electrical brain activity and a person’s emotional states [2, 3].

This paper proposes a method of comparative cluster analysis of multidimensional EEG signal data obtained while reproducing the same typical emotional state of the test subject.

Methods of classification of electroencephalogram

The experiment was conducted using an electroencephalograph that recorded data from 23 channels based on a standard electrode placement scheme. The test subject was seated in front of a laptop screen. Emotional stimuli consisted of images presented in the following sequences: 10 positive, 10 negative, and 20 mixed photographs. A 4-second EEG recording was conducted for each image.

From the EEG signals, spatial and temporal features were extracted and analyzed using Fast Fourier Transform (FFT) to construct tables of amplitudes, powers, and frequencies. Classification was performed by calculating the barycenter for each channel across the series. For new series, the Euclidean distance to these barycenter was determined, allowing assignment of the EEG signal to the structurally closest class. Figure 1 shows the resulting barycenter signature.

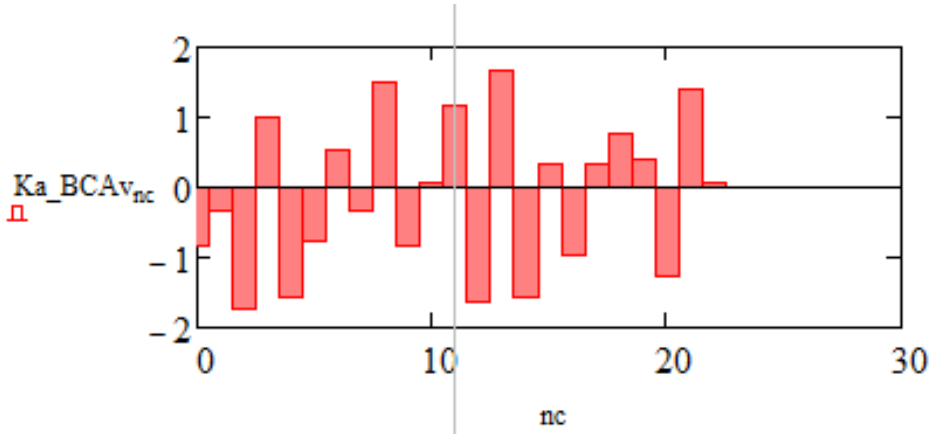

Figure 1 - Barycenter signature

To evaluate classification accuracy, control EEG samples were used. Figure 2 displays the classification results for the subject's emotional state. The TABL matrix includes two columns: N (negative emotions) and P (positive emotions), constructed from the respective EEG series. Values marked as "1" represent correct classifications, while deviations from P or N indicate misclassifications.

The results showed that all EEG series within defined clusters were classified correctly (100% accuracy). For the control datasets (TABL04 and TABL59), formed from mixed stimuli, the classification accuracy reached 65%.

Figure 2 - Classification results matrix of emotional EEG responses

Summary and conclusions.

This study proposed and tested a method for classifying electroencephalogram signals based on cluster analysis and barycenter computation. The obtained results confirm the feasibility of identifying a person's emotional state with an accuracy of 65% using spatial-frequency EEG analysis. The method demonstrated reliability for clearly defined clustered states and requires further improvement to increase classification accuracy under conditions involving mixed stimuli.

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